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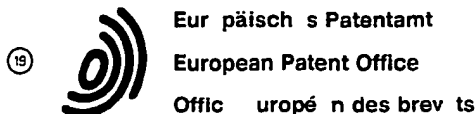
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54 **7-(Substituted)amino-8-(substituted)Carbonyl-methylamino-1-oxaspiro (4,5)decanes as diuretics**
antiinflammatory, and cerebrovascular agents.

57 Methods for using substituted phenoxy-, 1-, and 2-naphthalenyloxy-, indenyl-, indolyl-, benzo[b]-furanyl-, and benzo[b]thienylcarboxamides of 7,8-(substituted-diamino)-1-oxaspiro[4.5]decanes as cerebrovascular, diuretic, and antiinflammatory agents are disclosed. Pharmaceutical compositions employing the compounds are also disclosed.

EP 0 393 696 A2

**7-((SUBSTITUTED)AMINO)-8-((SUBSTITUTED)CARBONYL)-METHYLAMINO)-1-OXASPIRO(4,5)DECANES
AS DIURETICS ANTIINFLAMMATORY, AND CEREBROVASCULAR AGENTS**

BACKGROUND OF THE INVENTION

The present invention is related to a method of using 7-((substituted)amino-8-((substituted)carbonyl)-methylamino)-1-oxaspiro(4.5)decanes and the pharmaceutically acceptable salts thereof for the manufacturing of diuretic, antiinflammatory, and cerebrovascular pharmaceuticals. The compounds, processes for preparing them, and pharmaceutical compositions containing them are found in United States Patent 4,737,493, which is herein incorporated by reference. The disclosed utility in the patent is analgesic. The compounds are also disclosed as having sedative, diuretic, and corticosteroid elevating effects and therefore as being useful diuretic and psychotherapeutic agents.

United States Patent 4,598,087 covers certain substituted trans-1,2-diamino-cyclohexyl amide compounds which demonstrate selective opioid receptor binding. They are disclosed as useful as analgesics, diuretics, and psychotherapeutic agents.

United States Patent 4,663,343 covers certain substituted naphthalenyloxy-1,2-diaminocyclohexyl amide compounds which possess selective kappa opioid receptor site binding activity and are useful as analgesics and diuretics.

European Application 258,095 discloses decahydroquinoline derivatives and European application 258,096 covers 1,2-diaminoindane derivatives. The compounds are analgesics with strong affinity for opiate receptors. The compounds are also mentioned as having diuretic, antiarrhythmic, cerebral antiischemic and hypotensive activity.

European Application 260,041 covers 1-acyl-substituted piperidine derivatives useful as analgesics with specific agonist effect on K receptors.

European Application 261,842 covers certain acylated-(1-(phenyl or benzyl)-1,2-ethylene diamines which are K-receptor agonists which act as analgesics through interaction with kappa opioid receptors.

European Application 254,545 covers 1,2-ethylene diamine compounds having analgesic, diuretic and antiinflammatory activity.

United States Patent 4,499,286 covers trans-cyclohexane-1,2-diamine derivatives of thienylacetic acid. The compounds are disclosed as having analgesic activity.

European Application 260,555 covers benzo-fused cycloalkane and oxa- and thia-, cycloalkane trans-1,2-diamine derivatives useful as analgesic and diuretics.

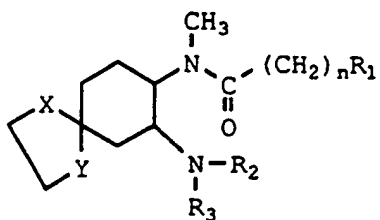
SUMMARY

The present invention relates to a new method for the manufacturing of pharmaceuticals for treating cerebrovascular disorders. Such disorders include, but are not limited to, cerebral ischemia or cerebral infarction resulting from a range of conditions such as thromboembolic or hemorrhagic stroke. The method comprises the use of a compound of formula I as described hereinafter.

Compounds of formula I are also useful as diuretics and antiinflammatory agents. Pharmaceutical compositions are also included in the present invention.

DETAILED DESCRIPTION

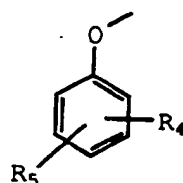
The present invention provides certain substituted oxaspirodiaminocyclohexane compounds which are useful as diuretic, antiinflammatory, and cerebrovascular agents. The compounds are



I

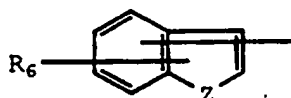
wherein n is an integer of from one to six; either of X or Y is oxygen and the other is -CH₂-;
R₁ is selected from

a)



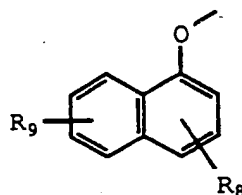
where R₄ and R₅ are independently hydrogen, fluorine, chlorine, bromine, nitro, trifluoromethyl, alkyl of from one to six carbon atoms, alkoxy of from one to six carbon atoms, or aryl;
b) 3,4,5-trimethylphenoxy;

c)



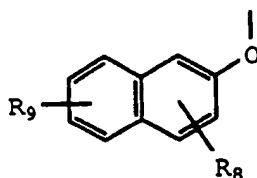
where R₆ is hydrogen, fluorine, chlorine, alkyl of from one to six carbon atoms, or aryl; Z is -CH₂-, -O-, -S-, or -NR₇- where R₇ is hydrogen, alkanoyl of from one to six carbon atoms, or alkyl of from one to six carbon atoms;

d)



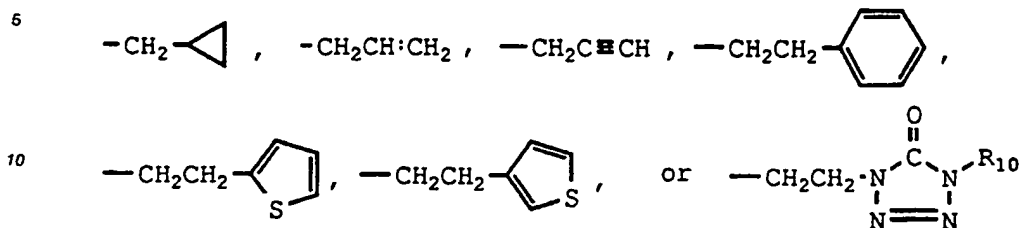
where R₈ and R₉ are independently hydrogen, fluorine, bromine, alkyl of from one to six carbon atoms, or alkoxy of from one to four carbon atoms; or

e)



where R_8 and R_9 are as defined above;

R_2 is methyl and R_3 is hydrogen, alkyl of from one to six carbon atoms,



15 where R_{10} is alkyl of from one to four carbon atoms; or where R_2 and R_3 when taken together with the nitrogen atom to which they are attached, form a pyrrolidinyl, piperidinyl, or hexahydro-1H-azepinyl ring; and the pharmaceutically acceptable acid addition salts thereof.

The compounds of the present invention constitute a class of derivatives of certain substituted oxaspirodiaminocyclohexane compounds of formula I above in which one nitrogen atom is an amine nitrogen substituted with methyl and a second substituent selected from the group R_3 as defined above, or

20 when taken together with the nitrogen atom to which they are attached, R_2 and R_3 form a pyrrolidinyl, piperidinyl, or hexahydro-1H-azepinyl ring, and the other nitrogen atom is a N-methyl amide nitrogen further substituted with the group R_1 , as defined above.

Compounds of the present invention contain one or more asymmetric carbon atoms and therefore exist in various stereoisomeric forms. Additionally, the compounds of this invention are capable of existing in

25 different geometric isomeric forms. For example, the oxygen atom of the 5-membered spiro-ring may be positioned on the same side of the average plane of the cyclohexane ring as the amide nitrogen, or on the side opposite. The present invention contemplates all geometric and stereoisomeric forms of the compounds of formula I above.

The individual stereoisomers are obtained, if desired, from mixture of the different forms by known

30 methods of resolution such as the formation of diastereomers, followed by recrystallization.

Compounds of the instant invention include solvates, hydrates, and salts of formula I above.

Preferred compounds of the present invention are those of formula I above wherein R_1 is



where R_4 and R_5 are independently hydrogen, fluorine, chlorine, bromine, nitro, trifluoromethyl, alkyl of from one to six carbon atoms, alkoxy of from one to six carbon atoms, or aryl.

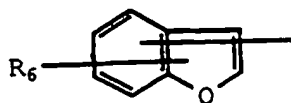
45 By the term "aryl", is meant phenyl; phenyl substituted with fluorine, chlorine, alkoxy of from one to four carbon atoms, nitro, or trifluoromethyl; 2- or 3-thienyl; and 2- or 3-thienyl substituted with alkyl of from one to four carbon atoms or alkoxy of from one to four carbon atoms.

Preferred compounds of the present invention are those of formula I above where R_1 is



55 wherein R_6 is as defined above. The most preferred compounds are substituted inden-1-yl compounds of formula I above.

Other preferred compounds of the present invention are those of formula I wherein R_1 is

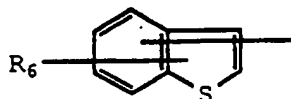


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wherein R is as defined above. The most preferred compounds are substituted benzofuran-4-yl compounds of formula I.

Yet other preferred compounds of the present invention are those of formula I wherein R₁ is

10

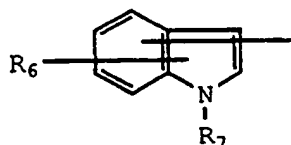


15

wherein R₆ is as defined above. The most preferred compounds are substituted benzo[b]thiophen-4-yl compounds of formula I.

Yet other preferred compounds of the present invention are those of formula I wherein R₁ is

20

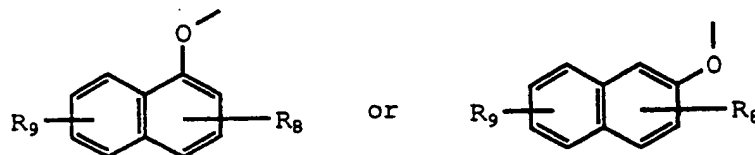


25

wherein R₆ and R₇ are as defined above. The most preferred compounds are indol-4-yl compounds of formula I.

Yet other preferred compounds of the present invention are those of formula I wherein R₁ is

30



35

wherein R₈ and R₉ are independently hydrogen, fluorine, chlorine, bromine, alkyl of from one to four carbon atoms or alkoxy of from one to four carbon atoms.

Preferred substituents for R₂ and R₃ are those where R₂ is methyl and R₃ is lower alkyl, most preferably methyl, or where R₂ and R₃ taken together with the nitrogen atom to which they are attached form a pyrrolidinyl ring.

Preferred compounds of the present invention include but are not limited to:

45 5R-(5 α ,7 α ,8 β)]-N-Methyl-N-[7-(methyl-2-propynylamino)-1-oxaspiro[4.5]dec-8-yl]-2-phenoxyacetamide,
 [5S-(5 α ,7 α ,8 β)]-N-Methyl-N-[7-(methyl-2-propynylamino)-1-oxaspiro[4.5]dec-8-yl]-2-phenoxyacetamide,
 [5R-(5 α ,7 β ,8 α)]-N-Methyl-N-[7-(methyl-2-propynylamino)-1-oxaspiro[4.5]dec-8-yl]-2-phenoxyacetamide,
 [5S-(5 α ,7 β ,8 α)]-N-Methyl-N-[7-(methyl-2-propynylamino)-1-oxaspiro[4.5]dec-8-yl]-2-phenoxyacetamide,
 50 [5R-(5 α ,7 α ,8 β)]-2-(4-Fluorophenoxy)-N-methyl-N-[7-(1-pyrrolidinyl)]-1-oxaspiro[4.5]dec-8-yl]acetamide,
 [5S-(5 α ,7 α ,8 β)]-2-(4-Fluorophenoxy)-N-methyl-N-[7-(1-pyrrolidinyl)]-1-oxaspiro[4.5]dec-8-yl]acetamide,
 5R-(5 α ,7 β ,8 α)]-2-(4-Fluorophenoxy)-N-methyl-N-[7-(1-pyrrolidinyl)]-1-oxaspiro[4.5]dec-8-yl]acetamide,
 [5S-(5 α ,7 β ,8 α)]-2-(4-Fluorophenoxy)-N-methyl-N-[7-(1-pyrrolidinyl)]-1-oxaspiro[4.5]dec-8-yl]acetamide,
 [5R-(5 α ,7 α ,8 β)]-2-(4-Fluorophenoxy)-N-methyl-N-[7-[methyl-(2-phenylethyl)amino]-1-oxaspiro[4.5]dec-[5R-
 55 (5 α ,7 α ,8 β)]-2-(4-Fluorophenoxy)-N-methyl-N-8-yl]acetamide,
 [5S-(5 α ,7 α ,8 β)]-2-(4-Fluorophenoxy)-N-methyl-N-[7-[methyl-(2-phenylethyl)amino]-1-oxaspiro[4.5]dec-8-yl]-
 acetamide,
 [5R-(5 α ,7 β ,8 α)]-2-(4-Fluorophenoxy)-N-methyl-N-[7-[methyl-(2-phenylethyl)amino]-1-oxaspiro[4.5]dec-8-yl]-

acetamide,
[5S-(5a,7β,8α)]-2-(4-Fluorophenoxy)-N-methyl-N-[7-{methyl-(2-phenylethyl)amino}-1-oxaspiro[4.5]dec-8-yl]-
acetamide,
[5R-(5a,7α,8β)]-N-Methyl-2-(3-nitrophenoxy)-N-[7-(1-pyrrolidinyl)-1-oxaspiro[4.5]dec-8-yl]acetamide,
5 [5S-(5a,7α,8β)]-N-Methyl-2-(3-nitrophenoxy)-N-[7-(1-pyrrolidinyl)-1-oxaspiro[4.5]dec-8-yl]acetamide,
[5R-(5a,7β,8α)]-N-Methyl-2-(3-nitrophenoxy)-N-[7-(1-pyrrolidinyl)-1-oxaspiro[4.5]dec-8-yl]acetamide,
[5S-(5a,7β,8α)]-N-Methyl-2-(3-nitrophenoxy)-N-[7-(1-pyrrolidinyl)-1-oxaspiro[4.5]dec-8-yl]acetamide,
[5R-(5a,7α,8β)]-N-Methyl-N-[7-(1-pyrrolidinyl)-1-oxaspiro[4.5]dec-8-yl]-2-[3-(trifluoromethyl)-phenoxy]-
acetamide,
10 [5S-(5a,7α,8β)]-N-Methyl-N-[7-(1-pyrrolidinyl)-1-oxaspiro[4.5]dec-8-yl]-2-[3-(trifluoromethyl)-phenoxy]-
acetamide,
[5R-(5a,7β,8α)]-N-Methyl-N-[7-(1-pyrrolidinyl)-1-oxaspiro[4.5]dec-8-yl]-2-[3-(trifluoromethyl)-phenoxy]-
acetamide,
[5S-(5a,7β,8α)]-N-Methyl-N-[7-(1-pyrrolidinyl)-1-oxaspiro[4.5]dec-8-yl]-2-[3-(trifluoromethyl)-phenoxy]-
15 acetamide,
[5R-(5a,7α,8β)]-2-(3,4-Dichlorophenoxy)-N-methyl-N-[7-(1-pyrrolidinyl)-1-oxaspiro[4.5]dec-8-yl]acetamide,
[5S-(5a,7α,8β)]-2-(3,4-Dichlorophenoxy)-N-methyl-N-[7-(1-pyrrolidinyl)-1-oxaspiro[4.5]dec-8-yl]acetamide,
[5R-(5a,7β,8α)]-2-(3,4-Dichlorophenoxy)-N-methyl-N-[7-(1-pyrrolidinyl)-1-oxaspiro[4.5]dec-8-yl]acetamide,
[5S-(5a,7β,8α)]-2-(3,4-Dichlorophenoxy)-N-methyl-N-[7-(1-pyrrolidinyl)-1-oxaspiro[4.5]dec-8-yl]acetamide,
20 [5R-(5a,7α,8β)]-2-(2,6-Dichlorophenoxy)-N-methyl-N-[7-(1-pyrrolidinyl)-1-oxaspiro[4.5]dec-8-yl]acetamide,
[5S-(5a,7α,8β)]-2-(2,6-Dichlorophenoxy)-N-methyl-N-[7-(1-pyrrolidinyl)-1-oxaspiro[4.5]dec-8-yl]acetamide,
[5R-(5a,7β,8α)]-2-(2,6-Dichlorophenoxy)-N-methyl-N-[7-(1-pyrrolidinyl)-1-oxaspiro[4.5]dec-8-yl]acetamide,
[5S-(5a,7β,8α)]-2-(2,6-Dichlorophenoxy)-N-methyl-N-[7-(1-pyrrolidinyl)-1-oxaspiro[4.5]dec-8-yl]acetamide,
[5R-(5a,7α,8β)]-2-(3,5-Dichlorophenoxy)-N-methyl-N-[7-(1-pyrrolidinyl)-1-oxaspiro[4.5]dec-8-yl]acetamide,
25 [5S-(5a,7α,8β)]-2-(3,5-Dichlorophenoxy)-N-methyl-N-[7-(1-pyrrolidinyl)-1-oxaspiro[4.5]dec-8-yl]acetamide,
[5R-(5a,7β,8α)]-2-(3,5-Dichlorophenoxy)-N-methyl-N-[7-(1-pyrrolidinyl)-1-oxaspiro[4.5]dec-8-yl]acetamide,
[5S-(5a,7β,8α)]-2-(3,5-Dichlorophenoxy)-N-methyl-N-[7-(1-pyrrolidinyl)-1-oxaspiro[4.5]dec-8-yl]acetamide,
[5R-(5a,7α,8β)]-N-Methyl-2-(1-naphthalenyloxy)-N-[7-(1-pyrrolidinyl)-1-oxaspiro[4.5]dec-8-yl]acetamide,
[5S-(5a,7α,8β)]-N-Methyl-2-(1-naphthalenyloxy)-N-[7-(1-pyrrolidinyl)-1-oxaspiro[4.5]dec-8-yl]acetamide,
30 [5R-(5a,7β,8α)]-N-Methyl-2-(1-naphthalenyloxy)-N-[7-(1-pyrrolidinyl)-1-oxaspiro[4.5]dec-8-yl]acetamide,
[5S-(5a,7β,8α)]-N-Methyl-2-(1-naphthalenyloxy)-N-[7-(1-pyrrolidinyl)-1-oxaspiro[4.5]dec-8-yl]acetamide,
[5R-(5a,7α,8β)]-N-Methyl-2-(2-naphthalenyloxy)-N-[7-(1-pyrrolidinyl)-1-oxaspiro[4.5]dec-8-yl]acetamide,
[5S-(5a,7α,8β)]-N-Methyl-2-(2-naphthalenyloxy)-N-[7-(1-pyrrolidinyl)-1-oxaspiro[4.5]dec-8-yl]acetamide,
[5R-(5a,7β,8α)]-N-Methyl-2-(2-naphthalenyloxy)-N-[7-(1-pyrrolidinyl)-1-oxaspiro[4.5]dec-8-yl]acetamide,
35 [5S-(5a,7β,8α)]-N-Methyl-2-(2-naphthalenyloxy)-N-[7-(1-pyrrolidinyl)-1-oxaspiro[4.5]dec-8-yl]acetamide,
[5R-(5a,7α,8β)]-N-Methyl-N-[7-{methyl[2-(2-thienyl)ethyl]amino}-1-oxaspiro[4.5]dec-8-yl]-2-(1-
naphthalenyloxy)acetamide,
[5S-(5a,7α,8β)]-N-Methyl-N-[7-{methyl[2-(2-thienyl)ethyl]amino}-1-oxaspiro[4.5]dec-8-yl]-2-(1-
naphthalenyloxy)acetamide,
40 [5R-(5a,7β,8α)]-N-Methyl-N-[7-{methyl[2-(2-thienyl)ethyl]amino}-1-oxaspiro[4.5]dec-8-yl]-2-(1-
naphthalenyloxy)acetamide,
[5S-(5a,7β,8α)]-N-Methyl-N-[7-{methyl[2-(2-thienyl)ethyl]amino}-1-oxaspiro[4.5]dec-8-yl]-2-(1-
naphthalenyloxy)acetamide,
[5R-(5a,7α,8β)]-N-Methyl-N[7(methyl-2-propenylamino)-1-oxaspiro[4.5]dec-8-yl]-1H-indene-3-acetamide,
45 [5S-(5a,7α,8β)]-N-Methyl-N[7(methyl-2-propenylamino)-1-oxaspiro[4.5]dec-8-yl]-1H-indene-3-acetamide,
[5R-(5a,7β,8α)]-N-Methyl-N[7(methyl-2-propenylamino)-1-oxaspiro[4.5]dec-8-yl]-1H-indene-3-acetamide,
[5S-(5a,7β,8α)]-N-Methyl-N[7(methyl-2-propenylamino)-1-oxaspiro[4.5]dec-8-yl]-1H-indene-3-acetamide,
[5R-(5a,7α,8β)]-N-Methyl-N[7-(1-pyrrolidinyl)-1-oxaspiro[4.5]dec-8-yl]-1H-indene-3-acetamide,
[5S-(5a,7α,8β)]-N-Methyl-N[7-(1-pyrrolidinyl)-1-oxaspiro[4.5]dec-8-yl]-1H-indene-3-acetamide,
50 [5R-(5a,7β,8α)]-N-Methyl-N[7-(1-pyrrolidinyl)-1-oxaspiro[4.5]dec-8-yl]-1H-indene-3-acetamide,
[5S-(5a,7β,8α)]-N-Methyl-N[7-(1-pyrrolidinyl)-1-oxaspiro[4.5]dec-8-yl]-1H-indene-3-acetamide,
[5R-(5a,7α,8β)]-N-[7-(Dimethylamino)-1-oxaspiro[4.5]dec-8-yl]-N-methyl-1H-indole-3-acetamide,
[5S-(5a,7α,8β)]-N-[7-(Dimethylamino)-1-oxaspiro[4.5]dec-8-yl]-N-methyl-1H-indole-3-acetamide,
[5R-(5a,7β,8α)]-N-[7-(Dimethylamino)-1-oxaspiro[4.5]dec-8-yl]-N-methyl-1H-indole-3-acetamide,
55 [5S-(5a,7β,8α)]-N-[7-(Dimethylamino)-1-oxaspiro[4.5]dec-8-yl]-N-methyl-1H-indole-3-acetamide,
[5R-(5a,7α,8β)]-N-Methyl-N-[7-(1-pyrrolidinyl)-1-oxaspiro[4.5]dec-8-yl]-1H-indole-3-acetamide,
[5S-(5a,7α,8β)]-N-Methyl-N-[7-(1-pyrrolidinyl)-1-oxaspiro[4.5]dec-8-yl]-1H-indole-3-acetamide,
[5R-(5a,7β,8α)]-N-Methyl-N-[7-(1-pyrrolidinyl)-1-oxaspiro[4.5]dec-8-yl]-1H-indole-3-acetamide,

- [5S-(5 α ,7 β ,8 α)]-N-Methyl-N-[7-(1-pyrrolidinyl)-1-oxaspiro[4.5]dec-8-yl]-1H-indole-3-acetamide,
 [5R-(5 α ,7 α ,8 β)]-N-Methyl-N-[7-(1-pyrrolidinyl)-1-oxaspiro[4.5]dec-8-yl]-2-benzofuranacetamide,
 [5S-(5 α ,7 α ,8 β)]-N-Methyl-N-[7-(1-pyrrolidinyl)-1-oxaspiro[4.5]dec-8-yl]-2-benzofuranacetamide,
 [5R-(5 α ,7 β ,8 α)]-N-Methyl-N-[7-(1-pyrrolidinyl)-1-oxaspiro[4.5]dec-8-yl]-2-benzofuranacetamide,
 5 [5S-(5 α ,7 β ,8 α)]-N-Methyl-N-[7-(1-pyrrolidinyl)-1-oxaspiro[4.5]dec-8-yl]-2-benzofuranacetamide,
 [5R-(5 α ,7 α ,8 β)]-N-Methyl-N-[7-(1-pyrrolidinyl)-1-oxaspiro[4.5]dec-8-yl]-3-benzofuranacetamide,
 [5S-(5 α ,7 α ,8 β)]-N-Methyl-N-[7-(1-pyrrolidinyl)-1-oxaspiro[4.5]dec-8-yl]-3-benzofuranacetamide,
 [5R-(5 α ,7 β ,8 α)]-N-Methyl-N-[7-(1-pyrrolidinyl)-1-oxaspiro[4.5]dec-8-yl]-3-benzofuranacetamide,
 [5S-(5 α ,7 β ,8 α)]-N-Methyl-N-[7-(1-pyrrolidinyl)-1-oxaspiro[4.5]dec-8-yl]-3-benzofuranacetamide,
 10 [5R-(5 α ,7 α ,8 β)]-N-Methyl-N-[7-(1-pyrrolidinyl)-1-oxaspiro[4.5]dec-8-yl]-4-benzofuranacetamide,
 [5S-(5 α ,7 α ,8 β)]-N-Methyl-N-[7-(1-pyrrolidinyl)-1-oxaspiro[4.5]dec-8-yl]-4-benzofuranacetamide,
 [5S-(5 α ,7 β ,8 α)]-N-Methyl-N-[7-(1-pyrrolidinyl)-1-oxaspiro[4.5]dec-8-yl]-4-benzofuranacetamide,
 [5R-(5 α ,7 α ,8 β)]-N-[7-[(Cyclopropylmethyl)methylamino]-1-oxaspiro[4.5]dec-8-yl]-N,2-dimethyl-3-benzofuranacetamide,
 15 [5S-(5 α ,7 α ,8 β)]-N-[7-[(Cyclopropylmethyl)methylamino]-1-oxaspiro[4.5]dec-8-yl]-N,2-dimethyl-3-benzofuranacetamide,
 [5R-(5 α ,7 β ,8 α)]-N-[7-[(Cyclopropylmethyl)methylamino]-1-oxaspiro[4.5]dec-8-yl]-N,2-dimethyl-3-benzofuranacetamide,
 [5S-(5 α ,7 β ,8 α)]-N-[7-[(Cyclopropylmethyl)methylamino]-1-oxaspiro[4.5]dec-8-yl]-N,2-dimethyl-3-benzofuranacetamide.
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More preferred compounds of the present invention include but are not limited to: (-) (5 α ,7 α ,8 β)-N-methyl-N-[7-pyrrolidinyl]-1-oxaspiro[4.5]dec-8-yl]-4-benzo[b]furanacetamide, and
 (-)-(5 α ,7 α ,8 β)-N-7-(1-pyrrolidinyl)-1-oxaspiro[4.5]dec-8-yl]-4-benzo[b]thiophene-4-acetamide

The compounds of formula I of the present invention have a very high kappa opioid affinity, selectivity
 25 and potency. For example, (-)-(5 α ,7 α ,8 β)-N-methyl-N-[7-(1-pyrrolidinyl)-1-oxaspiro[4.5]dec-8-yl]-4-benzo[b]furanacetamide gives a K_i of 0.73 nM with a μ/κ ratio of 798. The MPE_{50} in the rat paw pressure test for analgesia is 0.030 (iv) This is considerably better than any selective kappa opioid compound known to the inventors.

The compounds of the present invention possess significant analgesic activity, as disclosed in United
 30 States Patent 4,737,493, with the potential for minimum dependence liability due to their selective kappa opioid receptor properties. In addition to acting as analgesics, selective kappa opioid agonists also cause opioid receptor-mediated sedation, diuresis, and corticosteroid elevations. Accordingly, the compounds of the present invention are also useful diuretics, antiinflammatories, and psychotherapeutic agents.

The compounds of the formula I of the present invention also have application in congestive heart
 35 failure, advanced hepatic cirrhosis, nephrotic syndrome, chronic renal failure, trauma associated with surgery, emotional and physical stress, endocrine disorders, syndrome of inappropriate antidiuretic hormone secretion, and therapy with certain pharmacologic drug agents such as certain sulfonyl ureas, clofibrate, certain tricyclics such as carbamazepine, amitriptyline, thiothixene, flubenzamine, and thioridazine, certain antineoplastic agents, certain analgesics, and certain natriuretic diuretics.

The compounds of formula I of the present invention also have neuroprotective indications. As such,
 40 they are useful in the treatment of stroke and the treatment of cerebral ischemia (P. F. Vonvoightlander in Brain Research 435:174-180 (1987) and A. H. Tang, et al in Brain Research 403:52-57 (1987).)

The effectiveness of the aforementioned compounds as neuroprotective agents is determined by a
 45 pharmacological test procedure as described and illustrated below.

The surgical procedure is a modification of that originally proposed by A. Tamura, et al, J. Cereb. Blood Flow Metab., 1:53-60 (1981). It is similar to the methods described by D. Duverger, et al, J. Cereb. Blood Flow Metab. 8:449-461 (1988), and by S. Brint, et al, J. Cereb. Blood Flow Metab. 8:474-485 (1988). Male
 50 F-344 rats weighing 300-350 g were anesthetized in 2% halothane in room air. The right femoral vein was cannulated and the tubing led subcutaneously to an exit behind the neck to allow intravenous (IV) drug injection. The left common carotid was permanently occluded with a 6-0 silk ligature. The left middle cerebral artery (MCA) was exposed through a 2-mm burr hole drilled 1-2 mm rostral to the fusion of the zygomatic arch with the squamosal bone. The dura was cut, the MCA lifted off the surface of the brain, electrocauterized, and cut. The wound margins were sutured shut and the anesthesia stopped.

55 The compound, (-)-(5 α ,7 α ,8 β)-N-methyl-N-[7-(1-pyrrolidinyl)-1-oxaspiro[4.5]dec-8-yl]-4-benzo[b]furanacetamide, (0.5 mg/kg) and vehicle (0.9% saline) were administered IV 30 minutes and 24 hours after occlusion to groups of 12 animals each.

Forty-eight hours following occlusion rats were anesthetized with ketamine (150 mg/kg, IP), decapitated,

the brains rapidly removed, and placed on ice. With the aid of a brain mold (Activational Systems), the brain was sliced into four 2-mm sections: one section anterior to the MCA and three sections posterior to the MCA. The sections were then placed for 30 minutes in a 2% solution of 2,3,5-triphenyltetrazolium chloride (TTC) in saline. The brains were stored in 10% neutral buffered saline for analysis.

5 The brains were coded and the analysis was performed blind. The area of infarction in each section was outlined with the aid of a morphometric analysis program (Bioquant IV, R & M Biometrics). The TTC stain is converted into a red marker in live mitochondria, while the infarcted area remains white. The total volume of infarction was calculated from the areas of the four sections assuming two truncated cones. The mean area for each section and the mean total volume were calculated; vehicle and drug treatment were compared
10 using the Student's t-test. The means \pm standard deviation, % change, and statistical data are presented in Table I.

TABLE I

Section	Infarct Size (mm ²)*		Decrease	t-value	Probability
	Saline	Compound** (0.5 mg/kg)			
Anterior	8.9 \pm 5.4	6.5 \pm 1.9	-26.4	1.42	0.168
Anterior Medial	12.3 \pm 4.9	7.8 \pm 2.8	-36.8	2.76	0.011
Posterior Medial	10.8 \pm 8.5	4.0 \pm 5.2	-62.7	2.35	0.028
Posterior	9.3 \pm 8.7	1.8 \pm 4.1	-80.9	2.7	0.012
Total Volume	63.1 \pm 38.5	30.1 \pm 18.4	-52.3	2.68	0.013

* mm³ for total volume

35 **Compound is (-)-(5 α ,7 α ,8 β)-N-methyl-N-[7-1-pyrrolidinyl]-1-oxaspiro[4.5]dec-8-yl]-4-benzo[b]furanacetamide

40 In summary, the compound produced a significant decrease in the infarct area in three of the four brain sections and in the total volume. The data support the beneficial activity in the treatment of focal brain ischemia.

The compound, (-)-(5 α ,7 α ,8 β)-N-methyl-N-[7-1-pyrrolidinyl]-1-oxaspiro[4.5]dec-8-yl]-4-benzo[b]furanacetamide, was tested in carrageenan footpad edema test. Rats were injected IV with the compound, dissolved in saline, and administered at a final vehicle volume of 0.15 ml/kg. Fifteen minutes later the, rats
45 were injected in one rear footpad with 0.05 ml of a 1% solution of carrageenan. Five hours later swelling was measured in the injected hindpaw by mercury plethysmography. Indomethacin, a standard cyclooxygenase inhibitor, was administered orally as a control. The results are summarized in Table II below.

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55

TABLE II

Compound*	Route	Dose (mg/kg)	N	Delta Edema (x \pm SEM)	%I	P Value
Vehicle	IV		10	77 \pm 4.7		
Test compound	IV	0.01	10	55 \pm 4.9	29	>0.01
	IV	0.03	10	50 \pm 3.2	36	>0.001
	IV	0.1	10	49 \pm 2.5	37	>0.001
	IV	0.3	9	29 \pm 3.9	63	>0.001
	IV	1.0	9	19 \pm 3.7	75	>0.001
	IV	5.0	10	40 \pm 2.5	48	>0.001
Indomethacin	PO	5.0	10	40 \pm 2.5	48	>0.001

*As can be seen in the above table, the test compound is a potent inhibitor of the acute inflammatory response in rats

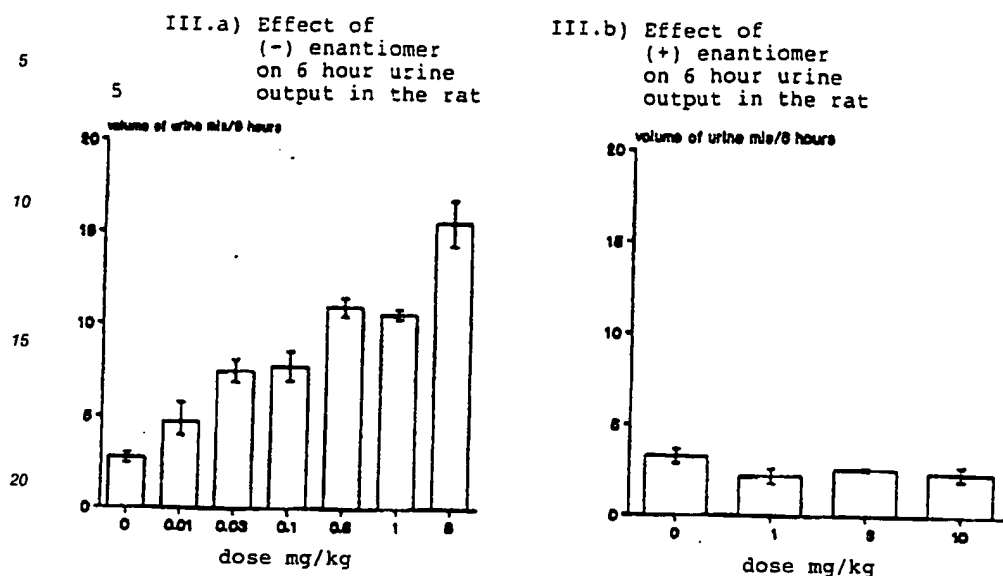
The diuretic effect of compounds of the instant invention is demonstrated below in Table III.

It is well established that kappa opiate agonists produce water diuresis in rats as in D.C. Horwell, *Drugs of the Future*, 13 1068 (1988). One highly selective kappa agonist is (\pm)-(5 α ,7 α ,8 β)-N-methyl-N-[7-(1-pyrrolidinyl)-1-oxaspiro[4.5]dec-8-yl]-4-benzo[b]furanacetamide, which is a mixture of two enantiomers. In vitro receptor binding studies demonstrate that the (-) enantiomer of the compound possesses very high affinity and selectivity for the kappa receptor and that the (+) enantiomer has much lower affinity.

Following subcutaneous administration a compound of the instant invention (-)-(5 α ,7 α ,8 β)-N-methyl-N-[7-(1-pyrrolidinyl)-1-oxaspiro[4.5]dec-8-yl]-4-benzo[b]furanacetamide, (-) enantiomer, produced a dose-related increase in the volume of urine produced over the six-hour test period (Table III). The maximum volume of urine produced by the highest dose tested was comparable to the maximum effect produced by (\pm)-(5 α ,7 α ,8 β)-N-methyl-N-[7-(1-pyrrolidinyl)-1-oxaspiro[4.5]dec-8-yl]-4-benzo[b]furanacetamide: 15.5 \pm 1.2 ml for the (-) isomer(-), (-)-(5 α ,7 α ,8 β)-N-methyl-N-[7-(1-pyrrolidinyl)-1-oxaspiro[4.5]dec-8-yl]-4-benzofuranacetamide compared to 14.9 \pm 0.7 ml for the racemate(\pm), (\pm)-(5 α ,7 α ,8 β)-N-methyl-N-[7-(1-pyrrolidinyl)-1-oxaspiro[4.5]dec-8-yl]-4-benzo[b]furanacetamide. As was expected from the in vitro receptor binding assays which suggested that the (+) enantiomer has negligible affinity for the kappa receptor, this compound was found to have no effect on urine output, as is shown in Figure IIIb.

These results together confirm that the kappa opiate receptor activity of the compound (\pm)-(5 α ,7 α ,8 β)-N-methyl-N-[7-(1-pyrrolidinyl)-1-oxaspiro[4.5]dec-8-yl]-4-benzo[b]furanacetamide resides entirely in the (-) enantiomer with the (+) enantiomer having no activity in the rat diuresis test, a reliable and sensitive test for detecting kappa opiate agonist activity in vivo.

TABLE III*



*Compound is (-)-(5 α ,7 α ,8 β)-N-methyl-N-[7-1-pyrrolidinyl]-1-oxaspiro[4.5]dec-8-yl]-4-benzofuran-acetamide

A comparison of the effects of (a) (-) enantiomer and (b) (+) enantiomer on urine output in the normally hydrated rat. Both compounds were dissolved in saline and administered subcutaneously in a dose volume of 1 ml/kg. Vehicle-treated controls received saline only. The data shown represent mean values (\pm SEM) for groups of six animals per dose level.

For the therapeutic uses described above, the usual mammalian dosage range for a 70-kg human subject is from 0.01 to 10 mg per day or 0.001 mg to 1.0 mg per kg of weight per day; optionally in divided portions. Determination of the proper dosage for a particular situation is within the skill of the art.

Pharmaceutical compositions of the compound of the present invention or its salts are produced by formulating the active compound in dosage unit form with a pharmaceutical carrier. Some examples of dosage unit forms are tablets, capsules, pills, powders, aqueous and nonaqueous oral solutions, and suspensions and parenteral solutions packaged in containers containing either one or some larger number of dosage units and capable of being subdivided into individual doses. Some examples of suitable pharmaceutical carriers, including pharmaceutical diluents, are gelatin capsules; sugars such as lactose and sucrose; starches such as corn starch and potato starch; cellulose derivatives such as sodium carboxymethyl cellulose, ethyl cellulose, methyl cellulose, and cellulose acetate phthalate; gelatin; talc; stearic acid; magnesium stearate; vegetable oils such as peanut oil, cottonseed oil, sesame oil, olive oil, corn oil, and oil of theobroma; propylene glycol; glycerin; sorbitol; polyethylene glycol; water; agar; alginic acid; isotonic saline; and phosphate buffer solutions; as well as other compatible substances normally used in pharmaceutical formulations. The compositions of the invention can also contain other components such as coloring agents, flavoring agents, and/or preservatives. These materials, if present, are usually used in relatively small amounts. The compositions can, if desired, also contain other therapeutic agents.

The percentage of the active ingredient in the foregoing compositions can be varied within wide limits, but for practical purposes it is preferably present in a concentration of at least 10% in a solid composition and at least 2% in a primarily liquid composition. The most satisfactory compositions are those in which a much higher proportion of the active ingredient is present.

Routes of administration of the subject compound or its salts are oral, parenteral, transdermal, or intranasal. For example, a useful intravenous dose is between 0.001 and 10 mg/kg. A preferred intravenous dose is 0.01 to 1 mg/kg. A still further preferred dose is 0.01 to 0.55 mg/kg. A useful oral dose is 0.01 to 30 mg/kg.

The following examples of formulations are provided to enable one skilled in the art to practice the

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invention. These examples are not intended to limit the scope of the invention in any way but rather to be illustrative thereof. Compound I is a compound of formula I as described hereinbefore.

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EXAMPLE 1

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Injectables

Compound I, Water for injection USP q.s.

15 The hydrochloride salt of Compound I is dissolved in water and passed through a 0.2-micron filter. Aliquots of the filtered solution are added to ampoules or vials, sealed, and sterilized.

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EXAMPLE 2

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Syrups	
2 mg Compound I/5 ml syrup	
Compound I	12.5 g
Purified Water USP	200 ml
Cherry Syrup qu	1000 ml

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Compound I is dissolved in the water and to this solution the syrup is added with mild stirring.

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EXAMPLE 3

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Capsules	
.5 mg, 1 mg, or 2 mg	
Compound I	250 g
Lactose USP, Anhydrous q.s. or	250 g
Sterotex Powder HM	5 g

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Combine Compound I and the lactose in a tumble, blend for two minutes, blend for one minute with the intensifier bar, and then tumble blend again for one minute. A portion of the blend is then mixed with the Sterotex Powder, passed through a #30 screen and added back to the remainder of the blend. The mixed ingredients are then blended for one minute, blended with the intensifier bar for thirty seconds, and tumble-blended for an additional minute. The appropriately sized capsules are filled with 141 mg, 352.5 mg, or 705 mg of the blend, respectively, for the 50-mg, 125-mg, and 250-mg containing capsules.

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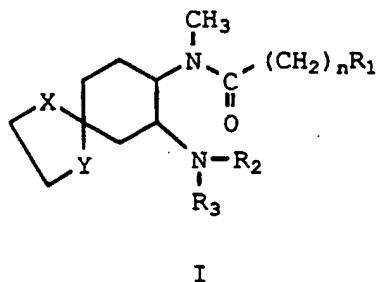
EXAMPLE 4

Tablets	
.5 mg, 1 mg, or 2 mg	
Compound I	125 g
Corn Starch NF	200 g
Cellulose, Microcrystalline	46 g
Sterotex Powder HM	4 g
Purified Water q.s. or	300 ml

Combine the corn starch, the cellulose, and Compound I together in a planetary mixer and mix for two minutes. Add the water to this combination and mix for one minute. The resulting mix is spread on trays and dried in a hot air oven at 50°C until a moisture level of 1 to 2 percent is obtained. The dried mix is then milled with a Fitzmill through a #RH2B screen, and added back to the milled mixture and the total blended for five minutes by drum rolling. Compressed tablets of 0.150 mg, 3.75 mg, and 7.50 mg, respectively, of the total mix are formed with appropriate sized punches the .50 mg, 1.25 mg, or 5.00 mg containing tablets.

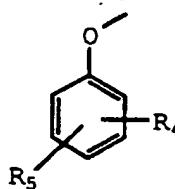
Claims

1. A method of use of a compound of formula

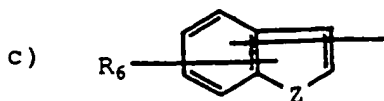


or a pharmaceutically acceptable salt thereof wherein n is an integer of from one to six; either of X or Y is oxygen and the other is -CH₂-; R₁ is selected from

a)



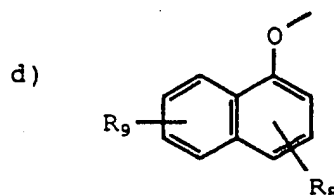
where R₄ and R₅ are independently hydrogen, fluorine, chlorine, bromine, nitro, trifluoromethyl, alkyl of from one to six carbon atoms, alkoxy of from one to six carbon atoms, phenyl; phenyl substituted with fluorine, chlorine, alkoxy of from one to four carbon atoms, nitro or trifluoromethyl; 2- or 3-thienyl; or 2- or 3-thienyl substituted with alkyl of from one to four carbon atoms or alkoxy of from one to four carbon atoms;
b) 3,4,5-trimethylphenoxy;



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where R_6 is hydrogen, fluorine, chlorine, alkyl of from one to six carbon atoms, phenyl; phenyl substituted with fluorine, chlorine, alkoxy of from one to four carbon atoms, nitro, or trifluoromethyl; 2- or 3-thienyl; or 2- or 3-thienyl substituted with alkyl of from one to four carbon atoms or alkoxy of from one to four carbon atoms; Z is $-\text{CH}_2-$, $-\text{O}-$, $-\text{S}-$, or $-\text{NR}_7-$ where R_7 is hydrogen, alkanoyl of from one to six carbon atoms, or alkyl of from one to six carbon atoms;

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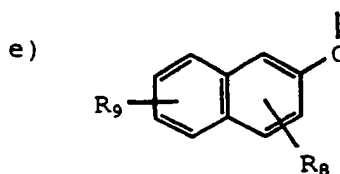


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wherein R_8 and R_9 are independently hydrogen, fluorine, bromine, alkyl of from one to six carbon atoms, or alkoxy of from one to four carbon atoms; or

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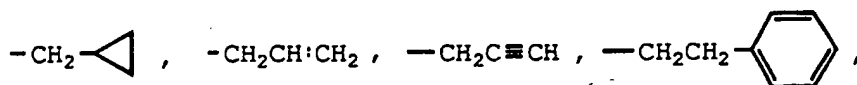


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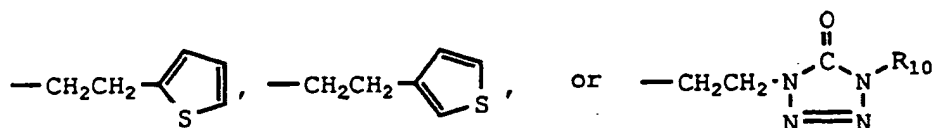
where R_8 and R_9 are as defined above;

where R_2 is methyl and R_3 is hydrogen, alkyl of from one to six carbon atoms,

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where R_{10} is alkyl of from one to four carbon atoms; or where R_2 and R_3 when taken together with the nitrogen atom to which they are attached, form a pyrrolidinyl, piperidinyl, or hexahydro-1H-azepinyl ring, for the manufacturing of pharmaceuticals for the treatment of cerebrovascular disorders or inflammation.

50

2. A method according to Claim 1 wherein the cerebrovascular disorder is stroke.

3. A method according to Claim 1 wherein the compound is (-)-5 α -7 α -8 β -N-methyl-N-[7-(1-pyrrolidinyl)-1-oxaspiro[4.5]dec-8-yl]-4-benzo[b]furanacetamide.

4. A method according to Claim 1 for the treatment with 0.001 mg to 10 mg/kg of weight per day of the compound or the pharmaceutically acceptable salt.

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5. A pharmaceutical composition comprising a cerebrovascularely or antiinflammatory effective amount of a compound as defined above in Claim 1 in combination with a pharmaceutically acceptable carrier.